Remarks:

The Examiner is thanked for the detailed Office Action in which claims 1-5 are rejected under 35 USC 112, second paragraph as being indefinite and for his suggestions for amending terminology in the claims. Claims 2-5 are not rejected over the prior art.

A discussion of the amendment to the specification and the amendments to claims 2-5 follows:

The amendment to page 5, line 1 replaces the terminology "nozzle thickness" with "nozzle length" which is the usual terminology for the distance between the front end and rear end of a nozzle. In the embodiment depicted in Fig. 1, the nozzle is a part of the front end wall of the liquid-gas jet device and the nozzle length is the same as the wall thickness. For purposes of the relationship of the nozzle length to the nozzle diameter set forth on page 5, line 20, it is the length of the nozzle and not the thickness of the wall in which the nozzle is embedded which is relevant. It is respectfully submitted that this amendment is the obvious correction of an obvious descriptive terminology error and therefore does not constitute new matter. The same explanation is offered as support for the amendment to claim 3, penultimate line, wherein "nozzle thickness" is changed to "nozzle length".

The amendments to claims 2, 4 and 5 are to replace original terminology with corresponding terminology which is more appropriate, taking into consideration the Examiner's comments.

Claim 1 is rejected under 35 USC 103 as being unpatentable over Popov (6,277,247) or applicants' disclosure of the admitted prior art with or without Tsegelsky (6,086,721) or Newton (3,701,264). The disclosure of "admitted prior art" refers to the disclosure on page 2, lines 8-18 which discusses the disclosure of RU 2087178 and the disclosure on page 1, lines 11-13 which generally relates to separating petrol fractions.

Method claim 1 is replaced by method claim 6. Claim 6 differs from claim 1 in that a new feature is added, namely that the counterpressure is 0.4 to 0.7 of the magnitude of the feed pressure. This is supported by the disclosure on page 6, line 15. Claim 6 further covers the subject matter of original claim 1 rewritten for clarity and to obviate the formal objections. Again, the Examiner is thanked for his suggestions.

New client 7 is supported by the disclosures on page 7, lines 1 and 2, page 15, lines 1 and 2, page 18, line 5 and the Examples on pages 9-10.

The discussions (which have been received from an applicant) of the prior art and the distinctions between applicants' claimed method and the methods of the prior art which is relied upon in the rejection, follow. The discussion points out the fundamental differences between the disclosure of each of the references and

references and applicants' claimed method. The discussion also deals with the combined teachings of the references to the extent that the discussion identifies features in the different references which are combined in the rejection notwithstanding that at least some of the disclosures of the separate references are inconsistent with each other and the lack of any suggestion or other indication in the prior art concerning combining disclosures from the prior art in the manner relied on in the rejection. This supports applicants' position that the claimed method is not obvious in view of each of the references which is relied upon and in view of combinations thereof.

Having analyzed the Examiner's arguments and three cited patents, as well as patent RU No. 2087178 indicated by the Applicant in the filed application, the Applicant advises as follows:

The methods of operation of the engineering solutions being compared, and the embodiments of the plants for implementing these methods have a number of differences. The distinguishing features of the claimed solution are described neither together, nor separately, in no one of the cited patents. Therefore the Applicant cannot agree with the Examiner's opinion that the claimed invention be "obvious".

A comparative analysis of the essential features of the claimed engineering solution and the features of the four patents is given below.

I. Regarding Popov USP 6,277,247 (PCT/RU 98/00137) "Operation method of a plant for distilling liquid products and plant for realizing the same" (hereinafter referred to as Patent I).

IA). The operation method of the plant according to Patent I comprises:

1. Feeding a stock product into a vacuum rectification column,
2. fractionating the stock product into a gas-vapor phase and at lest one liquid fraction in the vacuum rectification column,
3. evacuating the gas-vapor phase by a liquid-gas ejector,
4. delivering a motive liquid from a separator into a nozzle of the ejector,
5. entraining the gas-vapor phase by the motive liquid flowing out of the nozzle, subsequently mixing the motive liquid with the gas-vapor phase and compressing a gas-vapor component of the gas-vapor-liquid mixture,
6. Using a liquid with a molecular weight greater than 100 as a motive liquid;
7. discharging the gas-vapor-liquid mixture from the ejector to a shaped reservoir,
8. reducing flow velocity of the gas-vapor-liquid mixture in the reservoir,
9. And boosting static pressure of the gas-vapor-liquid mixture in the reservoir,

10. whereby conditions are created for condensing of condensable components of the gas-vapor-liquid mixture
11. attaining of a phase equilibrium and transforming the gas-vapor-liquid mixture into a gas-liquid mixture,
12. delivering the gas liquid-mixture from the shaped reservoir into a separator,
13. separating the gas-liquid mixture into the motive liquid and a compressed gas in the separator.

IB). The claimed engineering solution according to claim 1 "A method for processing multi-component liquid mixtures by vacuum distillation" comprises the steps of:

1. Feeding a hydrocarbon liquid mixture to a nozzle of a liquid-gas jet device
2. at a pressure of 1-12 MPa,
3. with its further discharging to a vacuum chamber;
4. Due to boiling up of part of the liquid mixture a two-phase supersonic flow is created in the vacuum chamber,
5. Whereafter a counterpressure is created (being lower than the initial pressure by the factor of 0.4-0.7 - see specification), which causes a pressure surge to form in the vacuum chamber of the jet device with an avalanche-like condensation of the gaseous component of the two-phase flow (during the pressure surge).

The main differences of the two methods being compared:

1) According to Popov USP 6,277,247, the distillation process takes place in a rectification column, and the liquid-gas ejector is designed for evacuating the gas-vapor phase from the column.

In the claimed invention, the liquid-gas jet device does not evacuate anything, but is intended for feeding the liquid hydrocarbon mixture.

2) According to Patent I the liquid-gas ejector feeds the mixture of gas-vapor phase and motive liquid into a shaped reservoir, wherein static pressure is boosted.

In the claimed invention the liquid hydrocarbon mixture is fed to a horizontal vacuum chamber, in which, due to the vacuum created by the jet effusing from the nozzle, the process of boiling up part of the liquid mixture is provided and a two-phase medium is formed in the vacuum chamber (rather than feeding, like in Patent I, the mixture already formed in the ejector to the shaped reservoir).

In the claimed invention, by creating a counterpressure in the vacuum chamber, a pressure surge is formed (with simultaneous condensation of the gaseous component of the two-phase flow) with an avalanche-like condensation of the gaseous component, i. e. condensation takes place during the pressure surge - a process of a sharp increase in pressure in the horizontal vacuum chamber.

According to Patent I the condensation process takes place within the shaped reservoir.

This is a fundamental difference, as in the claimed method it is during the pressure surge that the end product of vacuum distillation is being formed, and, as recited in the claims, it is in the vacuum chamber that said process takes place.

According to Patent I, no changes with the gas-vapor phase evacuated from the rectification column take place in the shaped reservoir besides condensation and separation of the mixture.

Therefore, in Patent I pressure is boosted in the shaped reservoir, rather than creating vacuum that would not allow to provide the condensation process, but, on the contrary, would lead to the boiling up of the motive liquid and, as a consequence, to inoperability of the system according to Patent I.

3) The pressure range in the claimed solution is obtained not on the basis of general engineering knowledge of those skilled in the art, but presents newly disclosed knowledge that has been obtained as a result of conducted research by performing experiments with liquid hydrocarbon media. At the same time, it should be pointed out to the Examiner that in the specification of the invention it is shown that depending on the nature of the liquid hydrocarbon medium said pressure range has its limits, for

example, for raw petrol it is 1-12 Mpa, for fuel oil 10-12 MPa, for crude oil 4-7 MPa. .

Analysis of the specification of Patent I showed that no pressure is indicated that is preferable for the operation of the ejector, and it is not indicated that feeding of the liquid hydrocarbon medium under pressure may cause changes in its characteristics.

IC). The system for distilling a liquid product of Patent I comprises :

1. A vacuum rectification column with pipelines for bleeding a gas-vapor phase and at least one liquid fraction,
2. a vacuum-producing device including a liquid-gas ejector,
3. with a separator
4. and with a pump;
5. a shaped reservoir,
6. a gas inlet of the liquid-gas ejector is connected to the pipeline for bleeding the gas-vapor phase, and a liquid inlet of the liquid-gas ejector is connected to the a discharge side of the pump, and
7. an outlet of the liquid-gas ejector is connected to an inlet of the shaped reservoir;

8. an inlet of the separator is connected to an outlet of the shaped reservoir, and a liquid outlet of the separator is connected to a suction side of the pump.

ID). The claimed engineering solution according to claim 2 "A plant for processing multi-component liquid mixtures by vacuum distillation" comprises:

1. A feeding pump,
2. a head delivery main and a discharge main,
3. control instrumentation,
4. a vacuum-producing device comprising
5. a horizontal vacuum chamber;
6. the vacuum-producing device is embodied as a liquid-gas-jet device,
7. connected to the head delivery main,
8. the nozzle of the liquid-gas-jet device is built in the front end wall of the vacuum chamber,
9. whose length relative to the diameter of its cavity is: $L = (7 - 10) * D$, wherein: L = length of vacuum chamber, D = diameter of vacuum chamber's cavity,
10. the plant contains a counterpressure regulator,
11. adapted to providing, jointly with the liquid-gas-jet device, conditions for forming a pressure surge in the vacuum chamber,

12. a manovacuummeter communicating with the vacuum chamber's cavity in its front part, and
13. connected by means of a pipeline to the rear end wall of the vacuum chamber.

Differences of the two plants being compared:

The above-described features of organizing the operation of the plants being compared have caused significant differences in their embodiment according to patent I and according to the claimed invention.

As a result, the plant according to the claimed invention has essential features 5, 8, 9, 10, 11, 12, and 13 that cannot be found in the engineering solution according to Patent I.

II. Regarding Popov RU_No. 2087178 (hereinafter referred to as Patent II)

"A method of vacuum distillation of a multicomponent liquid mixture, preferably of a hydrocarbon composition, and a plant for implementing the same".

IIA). The method of operation of the plant according to Patent II comprises the following steps:

1. feeding an original mixture into a rectification column under vacuum
2. fractionating the mixture into a gas-vapor phase and a liquid phase,

3. evacuating the gas-vapor phase by means of a vacuum-producing device
4. subsequently separating the gas-vapor phase by condensation into a liquid fraction and non-condensed gas-vapor fraction,
5. withdrawal of the latter for utilization,
6. using a liquid-gas jet device as the vacuum-producing device,
7. the liquid-gas jet device being connected to a closed reservoir embodied as a phase separator,
8. and to a pump to jointly form a circulation system,
9. the condensation is carried out in the phase separator,
10. and, after condensation, the liquid fraction is settled, and after its breakdown to continuous phase layers, withdrawn from the phase separator.
11. in separate flows as target fractions .

The main differences of the two methods being compared:

1) According to Popov RU No. 2087178, the distillation process takes place in a rectification column, and the liquid-gas jet device is intended only for evacuating the gas-vapor phase from the column.

In the claimed invention, the liquid-gas jet device does not evacuate anything, but is intended for feeding a liquid hydrocarbon mixture.

2) According to Patent II the liquid-gas jet device feeds a two-phase mixture at a pressure of over 0.15 MPa to a phase separator, wherein the final condensation of gases and vapors takes place, and the mixture is separated into a gaseous fraction and a liquid fraction.

In the claimed invention the liquid hydrocarbon mixture is fed into a horizontal vacuum chamber, in which, due to the vacuum created by the jet effusing from the nozzle, the process of boiling up part of the liquid mixture is provided and a two-phase medium is formed in the vacuum chamber (rather than feeding, like in Patent II, a mixture already formed in the liquid-gas jet device to a phase separator).

In the claimed invention, by creating a counterpressure in the vacuum chamber, a pressure surge is formed (with simultaneous condensation of the gaseous component of the two-phase flow) with avalanche-like condensation of the gaseous component, i.e. condensation takes place during the pressure surge - a process of a sharp increase in pressure in the horizontal vacuum chamber.

According to Patent II the condensation process is finished in the phase separator, there being no indications of the

formation of a pressure surge in the liquid-gas jet device or phase separator.

This is a fundamental difference, as in the claimed invention it is during the pressure surge that the end product of vacuum distillation is being formed, and, as recited in the claims, it is in the vacuum chamber that said process takes place.

According to Patent II, no changes with the gas-vapor phase evacuated from the rectification column take place in the phase separator besides condensation and separation of the mixture.

Therefore, in Patent II no vacuum is created in the phase separator, which would not allow to provide the condensation process, but, on the contrary, would lead to the boiling up of the liquid medium and, as a consequence, to inoperability of the plant according to Patent II.

3) The pressure range in the claimed solution is obtained not on the basis of general engineering knowledge of those skilled in the art, but presents newly disclosed knowledge that has been obtained as a result of conducted research by performing experiments with liquid hydrocarbon media. At the same time, it should be pointed out to the Examiner that in the specification it is shown that depending on the nature of the liquid hydrocarbon medium said pressure range has its limits, for example, for raw petrol it is 1-12 MPa, for fuel oil 10-12 MPa, for crude oil 4-7 MPa.

Analysis of the specification of Patent II showed that no pressure is indicated that is preferable for the operation of the liquid-gas jet device, and it is not indicated that feeding of a liquid hydrocarbon medium under pressure may cause changes in its characteristics.

IIB). The plant for vacuum distillation of a multi-component liquid mixture according to Patent II comprises:

1. A rectification column under vacuum
2. with a feedstock feed line,
3. and a gas-vapor discharge line connected to a vacuum-producing device,
4. and a branch tube for discharging non-condensed gas-vapors,
5. the vacuum-producing device is embodied as a circulation system of hydraulically communicating,
6. liquid-gas jet device
7. phase separator
8. and pump,
9. the phase separator is embodied as a closed reservoir with an inlet area for the gas-vapor-liquid jet from the pressure line of the jet device and a condensate settling area,

10. the jet inlet area is separated from the settling area by means of a hydraulic lock in the form of a dissipator-reflector of the jet's kinetic energy,
11. the settling area is provided with branch tubes for separated discharge of at least two liquid phases formed in the settling area after the breakdown of the condensate into continuous phase layers.

Differences of the two plants being compared:

The above-described features of organizing the operation of the plants being compared have caused significant differences in their embodiment according to Patent II and according to the claimed invention.

As a result, the plant according to the claimed invention has essential features 3, 5, 8, 9, 10, 11, 12, and 13 that cannot be found in the engineering solution of Patent II.

III. Comparative analysis relative to Tsegelsky USP 6,086,721, claim 1, (PCT/RU 97/23262) "Facility for distilling a liquid product" (hereinafter referred to as Patent III)

The unit according to Patent III comprises:

1. A vacuum column with means for feeding the liquid product and means for removing the vapor-gas phase
2. and a vacuum-creating device including

3. a jet device connected by its gas inlet to means for removing the vapor-gas phase of the vacuum column,
4. the vacuum-creating device is also provided with a pump
5. and a separator;
6. the pump being connected by its inlet with the separator;
7. the jet device is made as a liquid-gas jet device
8. the outlet of the liquid-gas jet device being connected by means of a pressure main with the separator
9. and by its liquid inlet the jet device is connected with the pump outlet.
10. the longitudinal axis of the liquid-gas jet device being positioned with deviation from the vertical of plus or minus 15 degrees,
11. an outlet cross section of a liquid supply nozzle of the liquid-gas jet device is positioned above the inlet of the separator at a height from 5 m to 35 m
12. and an outlet section of the pressure main is positioned below the liquid level in the separator to form a hydraulic seal.

The main differences of the claimed solution from the essential features according to Patent III concerning the method recited only in the specification of the patent:

1) In Patent III the operational method of the invention, namely, the distillation process takes place in the rectification

column, and the liquid-gas jet device, as a part of the vacuum-creating device, is intended only for removing the vapor-gas phase from the column and for partially condensing the vapor.

In the claimed invention the liquid-gas jet device does not remove anything, being intended for feeding the liquid carbon mixture.

2) According to Patent III the liquid-gas jet device feeds the two-phase mixture of vapor-gas phase and liquid working medium into a **vertical** (deviation of plus or minus 15 degrees) pressure main, wherein static pressure is boosted due to the height of the pressure main at whose inlet the liquid-gas jet device is mounted. Further, the reaction mixture is fed into the separator, whereby the final condensation of the vapor phase and light hydrocarbons takes place in the pressure main.

In the claimed invention the liquid hydrocarbon mixture is fed into a **horizontal** vacuum chamber, in which, due to the vacuum created by the jet flowing out from the nozzle a process of boiling up of part of the liquid mixture is provided and a two-phase medium is formed in the vacuum chamber (rather than feeding, like in Patent III, the two-phase medium already formed in the liquid-gas jet device to the pressure main).

In the claimed invention, by creating a counterpressure in the vacuum chamber a pressure surge is formed with an avalanche-like condensation of the gaseous component, i. e. the

condensation takes place during the pressure surge - a sharp increase in pressure in the horizontal vacuum chamber.

According to Patent III the condensation takes place partially in the liquid-gas jet device and partially in the pressure main.

The fundamental difference of the claimed method consists just in that during the pressure surge the process of formation of the end product of vacuum distillation takes place, and it is in the vacuum chamber that said process takes place, as recited in the claims.

According to Patent III, no changes with the vapor-gas phase evacuated from the rectification column take place in the liquid-gas jet device or the pressure main or the separator, besides the condensation of the vapor component of the mixture, increase in pressure and separation of the mixture containing the vapor-gas phase. Moreover, nothing is said about formation of any conditions for deliberate formation of a pressure surge in a strictly determined place. The two-phase mixture in Patent III is directed from the liquid-gas jet device to the vertical pressure main, which, in fact, allows to provide the process of falling of the two-phase mixture accompanied by a gradual prolonged process of increasing pressure in the pressure main, which allows completing the process of condensation of the vapor phase in the pressure main.

Analysis of the essential features according to Patent III showed that the maximum pressure, up to which the media mixture obtained in the liquid-gas jet device is compressed, is **0.11 MPa or higher**, i. e. indefinite, there being **no indications as to what magnitude of pressure is optimal for the task set, there also being no indications of rator. The fact that any changes in the characteristics of the compressed or condensed media may take place in the liquid-gas jet device, pressure main or sepa.**

Thus, it is obvious that the engineering solution according to Patent III and the claimed engineering solution achieve as a result of vacuum distillation a change in the chemical and a number of physical properties (for example, boiling temperature and octane number) by **different, non-similar methods:**

- vacuum rectification in a vacuum rectification column with creating vacuum therein by means of a liquid-gas jet device according to Patent III, and

- formation of a hydrocarbon medium with new properties in the claimed engineering solution in a vacuum chamber in an artificially created pressure surge at experimentally determined parameters individual for each specific medium. Therefore Tsegelsky USP 6,086,721 independently or in combination with Popov USP 6,277,247 could not suggest the claimed engineering solution for "the method" according to claim 1.

Besides, it should be noted that the plant according to the claimed invention has features 5, 8, 9, 10, 11, 12 and 13 that cannot be found in the engineering solution according to Patent III.

IV. Regarding Newton USP 3701264 "Controls for multi-phase ejector refrigeration systems" (hereinafter referred to as Patent IV).

According to claim 1 of the invention of Patent IV the essential features of the invention include:

1. An evaporator,
2. a vapor compressor adapted to compress a refrigerant,
3. a condenser receiving refrigerant vapor,
4. from said compressor,
5. said condenser operating to liquefy said refrigerant vapor,
6. a multi-phase ejector comprising
7. means defining a liquid chamber having a liquid inlet,
8. means defining a vapor chamber having a vapor inlet,
9. means defining a mixing chamber receiving liquid and vapor from said vapor and liquid chambers and having an outlet discharging a two-phase vapor-liquid stream,
10. a nozzle between and connecting said liquid chamber to said mixing chamber,

11. means connecting said condenser and said ejector and supplying high pressure liquid from said condenser to said liquid inlet and chamber and thereby to said nozzle,
12. a vapor-liquid separator receiving the two-phase refrigerant stream and adapted to separate said phases,
13. means for transferring the liquid phase from said separator to said evaporator,
14. means for connecting said evaporator to said vapor inlet,
15. means connecting said separator to said compressor,
16. means for controlling the flow of liquid between said nozzle and said condenser-ejector connecting means,
17. controlling means.

According to claim 4 of the invention the engineering solution of Patent IV, in addition to those listed above, includes:

18. a valve
19. valve-operating means,
20. means responsive to variations in temperature of the flowing vapor.

The main differences between the two solutions being compared, as far as the method is concerned, include:

1) In the engineering solution according to Patent IV there is no method of distillation at all, and the multi-phase ejector

is intended for providing the circulation of the liquid refrigerant through the evaporator, no means for creating a counterpressure being indicated at the ejector outlet, and the ejector evacuates refrigerant vapor from the evaporator and directs it to the separator, which enables the liquid refrigerant from the separator to get into the evaporator.

As was already noted above in analyzing the previous patents, in the claimed invention the liquid-gas jet device does not evacuate anything, but is intended for supplying the liquid hydrocarbon mixture.

2) According to Patent IV the multi-phase ejector feeds the two-phase mixture directly to the separator, wherein the refrigerant vapor is separated from the liquid refrigerant.

As was already noted above, in the claimed invention the liquid hydrocarbon mixture is fed to a horizontal vacuum chamber, wherein, due to the vacuum created by the jet flowing out of the nozzle, a process of boiling up of part of the liquid mixture is provided and a two-phase medium is formed in the vacuum chamber.

According to Patent IV the condensation process takes place in the condenser, into which vapor is supplied from the separator by means of a compressor especially designed for this purpose, as a rule, a centrifugal one, and the system has means for controlling the supply of the liquid refrigerant from the

condenser into the nozzle of the multi-phase ejector and for preventing refrigerant vapor from entering thereinto.

Thus, **the fundamental difference of the claimed method** consists in that it is during the pressure surge that the process of formation of the end product of vacuum distillation takes place, and, as indicated in the claims, it is in the vacuum chamber that said process takes place.

According to Patent IV, no changes in the chemical properties of the refrigerant take place in the multi-phase ejector or separator, and the system contains no means for regulating counterpressure in the multi-phase ejector. Moreover, the patent does not indicate formation of any conditions for deliberate formation of a pressure surge in a strictly determined place, which would probably require a vacuum chamber having strictly determined dimensions, and the medium flowing therein at strictly determined parameters, in particular, creating a strictly determined counterpressure.

Analysis of the specification to Patent IV showed that no data are given about the dimensions of the structural components constituting the refrigeration system, and no data about specific parameters of its operation.

Thus, it is obvious that the engineering solution according to Patent IV and the claimed method of processing multi-component

mixtures have different functions and are directed at resolving different technical problems.

Conclusion: the engineering solution according to Patent IV, both independently and in combination with Patent I and II, cannot obviously suggest to those skilled in the art the solution of the problem posed in the claimed engineering solution directed at processing of multi-component liquid mixtures by vacuum distillation using an artificially created pressure surge.

It is respectfully submitted that applicants' comprehensive discussion of the prior art relied upon in the rejection and of the differences between applicants' claimed method and the prior art provides a firm basis for the conclusion that applicants' claimed method is directed to subject matter which is not obvious in view of the prior art.

Entry of the present Amendment and allowance of the application is solicited.

Respectfully submitted,

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